underestimate. Second, performance goals are overstated, and a system's subsequent inability to meet overambitious objectives becomes the basis for expensive engineering modifications. Third, development and production schedules are compressed, leading to contractor inefficiency and cost growth on the one hand and to schedule slippage on the other. In combination, these effects work both to raise the overall costs of weapon systems and to inflate the cost growth observed in the course of the acquisition process.

Neither the Congress nor the Defense Department has managed to devise an effective counter to the "bidding in" incentives. 26/ The most common approach is to increase the degree of oversight. Within Defense, the activities of the Cost Analysis Improvement Group constitute one element of oversight, by providing independent cost estimates for the Secretary of Defense to consider in making acquisition decisions. The program review process and the independent analysis of the Office of Program Analysis and Evaluation (PA&E) is designed to provide the Secretary of Defense with more objective information to compare with that received from the services themselves. The Congress similarly has extended its oversight, especially through the detailed audits and program assessments conducted by the General Accounting Office. When exercised by either the Congress or the Secretary of Defense, additional oversight leads to detailed changes in service proposals, funding requests, acquisition planning, or prioritization. Predictably, the services oppose such involvement as "micromanagement."

26/ One complex device, the "limitation of government obligation" clause, attempted to minimize contractors' incentive to "bid in" on R & D contracts. The clause stipulated that once a funding plan had been negotiated, the contractor could be required to complete work even if all funds were expended prior to completion. The incentive thus created was for contractors to reveal their best estimates of funding requirements before the government became "locked in" to a single contractor, who could then extract profitable change orders. The effectiveness of this approach was reduced by a Congressional stipulation that contractors' obligations could not be forced to exceed $3 billion, a sum too small to enforce continuation of work in many instances. See Harvey J. Gordon, "A Discussion of Nine Clauses Uniquely Suitable for Use in Major Systems Contracting," National Contract Management Journal, vol. 13 (Summer 1979), pp. 141-4.

An alternative often advocated but rarely employed is to impose external fiscal discipline on the acquisition process. The Congress has taken a first step in this direction by enacting Sec. 1107 of the fiscal year 1983 defense authorization act, P.L. 97-252. Sec. 1107 begins by establishing each weapon system's baseline cost estimates as the total and unit costs projected when the system first appears in the SAR. These estimates are stated in nominal terms, so that projected costs must include anticipated inflation. The baseline costs are updated annually, but the updated costs lag at least one year behind current cost estimates. The purpose of this one-year-plus lag is to provide a period within which cost growth can be measured in comparison to the (annually updated) baseline. Whenever a system's total or unit cost exceeds its baseline estimate by 15 percent or more, the Department of Defense is required to notify Congress and to provide a detailed explanation of the system's cost growth. If cost growth exceeds 25 percent, the system is subject to automatic termination within 60 days.

Sec. 1107 thus creates external incentives for the military services to control cost growth. Program managers whose systems experience cost growth of 15 percent or more in a single year face the unpleasant prospect of reporting the increases to the Secretary of Defense and the Congress, and of receiving additional Congressional attention in the future. Cost growth of 25 percent in a single year creates the presumption of program termination, unless the department provides assurances to the Congress regarding the program's essentiality for national security and the department's anticipated improvements in controlling its cost. The stipulation that all costs be measured in nominal dollars forces the department to budget realistically for inflation in order to avoid becoming subject to the Sec. 1107 reporting requirements.

By itself, however, Sec. 1107 does not impose external fiscal discipline on the acquisition process. The Congress can waive the reporting requirements for any system; more important, it can relax the stringent oversight provisions by permitting the Defense Department to continue programs that experience rapid cost growth. Sec. 1107 will promote effective management of weapon system acquisition only if the Congress allows the services to be penalized in instances of mismanagement.

Encourage Competition to Hold Down Cost Growth. A Rand Corporation analysis based on cost comparisons of ten systems found some evidence that competitive procurement had led to modest improvements in system performance and on-schedule delivery by contractors, and had

substantially lowered real cost growth. 27/ Although the small number of cases makes this finding inconclusive, numerous other studies using a variety of other approaches have reached similar conclusions. 28/ There is considerable question about the magnitude of savings to be gained from competitive procurement and the extent to which competitive pressures improve contractor performance. Competitive procurement has offered savings in many instances in the past, however, and should be the acquisition model of choice in the future. 29/

The Department of Defense is currently employing many techniques of competitive procurement developed with earlier systems. 30/ Among them are:

- o Dual or second sourcing. A second contractor is established for the purpose of achieving parallel production capability for future competition.

- o Leader/follower. In this approach to second sourcing, the developer or sole producer of a system (the leader company)

27/ Acquisition Policy Effectiveness, p. 28. System performance improved by 9 percent and scheduled delivery by 10 percent. Program cost fell by an average of 32 percent for the ten systems.

28/ Eleven such studies are summarized by The Analytic Sciences Corporation, An Analysis of the Impact of Dual Sourcing of Defense Procurements (TASC, August 7, 1981), Table 1.1-1, p. 1-2. In these studies, estimated savings from competition averaged 37 percent.

29/ In general, weapons systems should be acquired competitively if the benefits from competition--cost savings and performance or schedule improvements --outweigh its additional costs, including start-up costs and additional contract administration. For a discussion of these tradeoffs, see G. Daly, H. Gates, and J. Schuttinga, The Effect of Price Competition on Weapon System Acquisition Costs (Institute for Defense Analyses, September 1979).

30/ Letter from Secretary of Defense Caspar Weinberger to Senator John Tower, February 16, 1982, Enclosure 1.

furnishes manufacturing assistance and know-how to a follower company, selected by the leader company or by the government, to enable the follower company to become a second source of supply for the system and a future competitor.

- o Joint teaming. A team of two or more firms is awarded a development contract, with the effort to be split among the firms. In the future, they will compete independently for production of the weapons system.

- o Competitive parallel development. Two or more firms develop and validate separate competing systems to meet a specific need, usually resulting in a prototype demonstration or fly-off between the competitors.

- o Directed subcontracting. This is a type of dual sourcing in which the prime contractor is required to develop a second source for a particular component through competitive subcontractors.

The services should be encouraged to expand use of these techniques, to apply whichever ones are most appropriate for particular weapon systems. Congress might also require the services to calculate and report on the savings realized from competitive procurement. Such a routine report on savings from competition could be made a part of the SAR. The Congress should consider amending current law to support second sourcing in order to promote competition and thus cut costs. Current law (10 U.S.C. 2304(a)(16)) permits second-source awards (at a price differential) only when they improve the department's ability to produce weapons quickly during a wartime mobilization.

Change the SAR to Report Reasons for Cost Growth. The Congress has used the SAR's tabulations of program costs as the primary source of data to support its oversight function for defense procurement. In addition to reporting on weapon systems' overall costs, the SAR tabulates cost variances as falling into one of seven categories: economic escalation, quantity change, schedule slippage, engineering modification, estimating change, support cost, or "other." Cost accounting techniques insure that all observed cost growth falls into one of these variance categories. In the case of escalation (defined as the difference between initially anticipated inflation and either observed or subsequently anticipated inflation), no further explanation is needed.

The other variance categories, however, merely assign cost growth without explaining it. Such explanations might be helpful in understanding

and curbing cost growth. For example, quantities may change because of funding limitations, redefinition of mission needs, or development of alternative systems. Schedules may slip because of development problems, contractor management inefficiencies, or funding constraints. Engineering modifications may be required to meet initial performance objectives, to improve performance to meet an enhanced mission requirement, or merely for the convenience of the contractor. In all these cases, and in others, the SAR is silent on the underlying reasons for cost growth. Moreover, the assignment of cost growth to one or another variance category appears frequently to be arbitrary, with differences noted among services and even among systems within a service. 31/

Identify Savings from Economical Production Rates. To avoid cost growth, weapon acquisition must proceed at efficient rates as well as remain on schedule. Although the Administration highlighted "economic production rates" as one of its management efficiencies for 1983 and beyond, its proposed rates for several systems were below those planned by its predecessor, and the Congress has since shown no reluctance to reduce annual procurement quantities for several of the Administration's programs. 32/ To focus attention on those systems where buy size is

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31/ For example, in the December 1981 SAR quantity changes in the Air Force F-15 and F-16 led to cost changes in four variance categories--engineering, estimating, quantity, and support. A quantity change in the Navy F-14 program resulted in quantity and support cost variances. Among Army programs, however, PATRIOT and MLRS quantity changes appeared as cost variances only in the quantity category.

In addition, the SAR total estimate often excludes major components of program costs, typically for military construction and support. Some of the affected systems as of the December 1981 SAR include PATRIOT and DIVAD gun (Army), Trident Submarine (Navy), and B-1B and NAVSTAR (Air Force). (Source: Congressional Budget Office, A Review.)

32/ As of the December 1981 SAR, program stretchouts added $3.9 billion in cost to 22 (of 47) SAR programs. Systems experiencing $200 million or more in program stretchout costs included the PERSHING II missile and Fighting Vehicle System (Army), F/A-18 and AV-8B aircraft and Trident submarine (Navy). (Source: Congressional Budget Office, A Review, Appendix A.)

important, the Administration could provide the Congress with an annual report estimating unit costs under alternative buy sizes. Such a report, which might be included with the December version of the SAR, would allow the Congress to make decisions about buy sizes if it accurately displayed their effects on costs.

It is important that such a report identify true savings from economical production rates, rather than mere changes in the timing of procurement costs. The Administration has estimated that over the next five years it would save $2.3 billion (in nominal dollars) from economical production rates. In calculating the savings from faster procurement, however, the Administration took the unit cost reductions associated with higher production rates and multiplied by the number of units that would have been procured under the Carter Administration's last five-year plan. In several cases, much of the savings calculated in this way merely reflects the outlay of near-term uninflated dollars rather than far-term highly inflated ones. In other cases, learning-curve effects are treated as savings from higher production rates. Since these learning-curve effects will be realized subsequently at the lower production rates as long as overall procurement quantity is not reduced, they do not represent actual savings over the course of the complete procurement cycle.

Table 1 illustrates the calculation in the case of the Army's division air defense (DIVAD) gun. Since this is a new weapon system, the unit cost reductions achieved through faster procurement may largely reflect learning-curve effects. The table shows that, if a 90 percent learning curve is appropriate for the DIVAD gun, then roughly two-thirds of the calculated savings stems from accelerated learning rather than from higher production rates. 33/

These calculations are only approximations, and do not necessarily apply to other weapon systems. Without detailed information on the

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33/ Under a 90 percent learning curve, doubling the quantity produced (say, from 50 to 100 units) leads to a 10 percent reduction in unit cost at the margin (that is, the cost of the 100th unit is 10 percent lower than the cost of the 50th). Aerospace applications frequently use an 85 percent learning curve. The more conservative 90 percent curve used in this example assumes less rapid cost reduction.

specific assumptions used for particular systems, it is difficult to judge whether substantial savings would remain after correcting both for learning curve effects and for differences in timing of expenditures. Differences in inflation assumptions embodied in the January 1981 and February 1982 budget calculations also complicate interpretation of the reported production rate savings. The need for care in estimating potential savings emphasizes the value of a periodic report that would show the Congress the effects on costs of the buy size decisions it will make in the future, rather than estimating savings relative to buy sizes proposed in the past.

Encourage Multiyear Contracting. One way to promote stable funding and the attainment of economical production rates is for the Defense Department to enter into long-term contracts with weapon system manufacturers. Multiyear contracting provides for cost savings by allowing contractors to buy and to produce components in economical lots exceeding one year's requirements. Multiyear contracting would be desirable only for systems whose designs and production goals are unlikely to change. Otherwise the substantial penalties associated with terminating a multiyear contract would erode savings. 34/

The Administration has estimated that multiyear contracting could reduce the defense budget by $1.1 billion over the next five years. Some of these savings may have been overstated, however. The Administration calculated the savings from multiyear contracting as the difference between the total funds that would be obligated over four (or five) years in the case of separate annual authorizations and the total funds obligated in the case of the multiyear authorization for the same procurement quantities, without discounting to obtain present values. This calculation tends to exaggerate the savings, because multiyear contracting leads to earlier outlays. The budget totals associated with multiyear contracts thus involve more valuable dollars.

34/ One analysis of multiyear contracting concludes that there are stringent conditions, which may not be met in practice, if multiyear contracts are to yield any savings. Absent those conditions, multiyear contracts might actually raise weapon system prices. See Kathleen P. Utgoff and Dick Thaler, The Economics of Multiyear Contracting (professional paper 345, Center for Naval Analyses, March 1982).

Table 2 illustrates the calculation for the F-16 fighter. The Administration estimates that multiyear contracting saves $246 million or 3.1 percent of the total budget request that would be associated with annual contracting over fiscal years 1982-1985. Discounting budget authority at a 10 percent rate, the savings shrink to $163 million or 2.4 percent of 1982-discounted dollars. The figures still support the Administration's contention that money is saved, but the savings are roughly one-third less than publicized.

Make More Use of Performance Testing. During the decade of the 1970s, according to the Rand Corporation, there was a trend toward an expansion of performance testing before undertaking final commitments to production. 35/ Rand found that performance testing contributed toward the attainment of performance goals, as might be expected. Moreover, systems which have undergone extensive pre-production performance testing should experience less cost growth during the production phase, because fewer engineering modifications should be needed to bring performance up to specifications.

If the merits of pre-production performance testing are not in dispute, the locus of responsibility for conducting the tests is. At present, the Undersecretary of Defense for Research and Engineering (USDR&E) has oversight for all performance testing, as well as for earlier (planning and development) and later (production and procurement) stages of the acquisition process. Some witnesses have asserted in Congressional testimony that the acquisition process is ill-served by placing all aspects under the control of USDR&E, because of the bureaucratic incentive thus created to approve systems as they pass from one stage to the next. 36/ These witnesses suggest assigning responsibility for testing to the services or elsewhere in the Office of the Secretary of Defense. The Congress may wish to consider this issue in the context of making structural changes in the acquisition process.

35/ Acquisition Policy Effectiveness, p. 21.

36/ Testimony of Russell Murray in Acquisition Process in the Department of Defense: Hearings Before the Committee on Governmental Affairs, U.S. Senate, October 21, 1981, p. 172; also testimony of R. James Woolsey, p. 458. For a less optimistic view of the merits of operational testing, see Task Force Report, p. 57.

TABLE 1: CALCULATED PROCUREMENT-COST SAVINGS FOR DIVAD GUN (Millions of Fiscal Year Dollars)

	1982	1983	1984	1985	1986	Total
			January 1981			
(1) Quantity	(12)	(24)	(32)	(46)	(72)	
(2) Procurement Cost	100.0	194.4	226.8	289.6	424.0	--
(3) Procurement Unit Cost	8.333	8.100	7.088	6.296	5.889	--
			February 1982			
(4) Quantity	(50)	(96)	(130)	(132)	(144)	--
(5) Procurement Cost	376.2	673.9	747.8	647.5	506.5	--
(6) Procurement Unit Cost	7.524	7.019	5.752	4.905	3.517	--
(7) Unit-cost Change	0.809	1.081	1.336	1.391	2.372	
(8) Quantity (Jan. 1981)	(12)	(24)	(32)	(46)	(72)	--
(9) Savings (7 x 8)	9.7	25.9	42.7	64.0	170.8	313.1
			Memo			
(10) Unit-cost change with a 90 percent learning curve	1.606	1.541	1.343	1.134	0.943	
(11) Net Unit-cost Change (7-10)	-0.797	-0.46	-0.007	0.257	1.429	
(12) Net Savings (8 x 11)	-9.57	-11.04	-0.224	11.822	102.89	93.88

NOTE: Net savings, the difference between total savings and learning-curve effects, represents the savings attributable to higher production rates. For a definition of the 90 percent learning curve, see note 33.

TABLE 2: CALCULATED PROCUREMENT-COST SAVINGS FROM F-16 MULTIYEAR CONTRACTING (Millions of Fiscal Year Dollars)

	1982	1983	1984	1985	Total
(1) Quantity	120	120	120	120	480
Annual Program					
(2) End Item	1,550.2	2,089.1	1,924.9	2,082.0	7,646.2
(3) Less Advance Funding	-161.9	-283.9	-216.8	-255.6	-918.2
(4) Net Request	1,388.3	1,805.2	1,708.1	1,826.4	6,728.0
(5) Advance Funding	268.6	220.8	270.6	340.1	1,296.0
(6) Total Budget Request	1,656.9	2,026.0	1,978.7	2,172.5	8,024.0
Multiyear Program					
(7) End Item	1,521.2	2,032.6	1,845.8	2,000.6	7,400.2
(8) Less Advance Funding	-161.9	-372.3	-274.0	-334.5	-1,142.7
(9) Net Request	1,359.3	1,660.3	1,571.8	1,666.1	6,257.5
(10) Advance Funding	546.8	180.9	256.8	346.1	1,520.5
(11) Total Budget Request	1,906.1	1,841.2	1,828.6	2,012.2	7,778.0
(12) Savings [(6) -(11)]	-249.2	184.8	150.1	160.3	246.0
(13) Percent of Total [(12) total ÷ (6) total]	--	--	--	--	3.1
Memo					
(14) Discounted Total Budget Request [(6) discounted] 1/	1,656.9	1,841.8	1,635.3	1,632.2	6,766.2
(15) Discounted Savings [(12) discounted] 1/	-249.2	168.0	124.0	120.4	163.3
(16) Discounted Savings as Percent of Discounted Total [(15) total ÷ (14) total] 1/	--	--	--	--	2.4

1/ Discounted to 1982 base using 10 percent rate of interest

Annotated Bibliography of

Major Studies

Norman J. Asher and Theodore F. Maggelet, On Estimating the Cost Growth of Weapon Systems (IDA Paper P-1494, Institute for Defense Analyses, October 1981). Documents schedule and cost growth in major DoD weapon system programs that have achieved initial operational capability. Uses SAR data to develop a methodology for projecting probable future cost growth in systems that have not yet reached IOC.

Comptroller General of the United States, Impediments to Reducing the Costs of Weapon Systems (General Accounting Office, November 8, 1979). Attempts to identify the major factors leading to increased weapon systems costs, discusses steps taken to control those costs, and recommends further actions. Concludes that past actions will not hold down overall costs because the principal factors in cost growth are the desire for high-technology systems and budget constraints that lead to uneconomical procurement and production practices.

Comptroller General of the United States, Improving the Effectiveness and Acquisition Management of Selected Weapon Systems: A Summary of Major Issues and Recommended Actions (General Accounting Office, May 14, 1982). Summarizes reports to the Congress on 24 major defense systems; identifies issues in system performance and effectiveness. Reviews program acquisition in the case of these 24 systems in terms of affordability, technical risk, cost effectiveness, incomplete reporting, adequacy of testing, program management, program concurrency, timeliness, and production readiness. Recommends changes in many acquisition programs.

Congressional Budget Office, A Review of the Department of Defense December 31, 1981 Selected Acquisition Report (Special Study, May 1982). Presents the results of a CBO review of the December, 1981 SAR. Looks at total cost changes in all SAR programs from September-December 1981; presents data to show the effect of cost growth on unit costs; measures the progress of DoD management initiatives; and evaluates the completeness and accuracy of information reported in the December 1981 SAR.

Defense Science Board, Report of the Acquisition Cycle Task Force (Defense Science Board 1977 Summer Study, March 15, 1978). Examines major acquisition case histories, changes in policy over the past two decades, and actual operation of the program advocacy and budgetary processes. Looks at causes of cost growth and possible remedies, especially ways to shorten the acquisition process. Urges flexibility in acquisition policy, tailoring the acquisition cycle to the specific weapon system.

E. Dews and G. Smith, A. Barbour, E. Harris, M. Hesse, Acquisition Policy Effectiveness: Department of Defense Experience in the 1970s (R-2516-DR&E, The Rand Corporation, October 1979). Uses quantitative analysis of SAR data (including data reported in the March 1978 SAR) to address five main questions: (1) did the so-called Packard initiatives of the early 1970s improve acquisition management; (2) have the results of the 1970s acquisition programs met the goals established when the programs entered full-scale development; (3) is management of 1970s programs more effective than that of the 1960s ones, in terms of these "result-to-goal" comparisons; (4) does it now take longer than in the past to develop and field systems; and (5) what new initiatives are suggested by the analysis?

Gerald R. McNichols and Bruce J. McKinney, Analysis of DoD Weapon Cost Growth Using Selected Acquisition Reports (TR-8047-1, Management Consulting and Research, Inc., February 27, 1981.) Uses the December, 1980 SAR as the data base to analyze weapon system costs and cost growth. Presents a briefing on cost growth issues including definitions, summary of the program cycle, magnitude of cost growth, trend analysis, comparisons by service and system, and cost growth by variance category.

Winfield S. Scott and Gregory E. Maust, A Comparison of Cost Growth in Major Missile Systems with that Experienced in Other Major Weapons Systems (paper presented to the 1980 meeting, Missiles and Astronautics Division, American Defense Preparedness Association, Fort Bliss, Texas, October 7-8, 1980). Compares cost growth in guided missile systems with that in other systems. Includes description of the SAR, analysis of cost growth variance categories, and presentation of basic data on individual system cost.